

**Remarks:**

Claims 1 and 26 have been amended and claim 4 has been cancelled. Claims 13-22 were previously cancelled. Accordingly, claims 1-3, 5-12 and 23-26 are currently pending for consideration.

**I. Amendments:**

Claim 1 has been amended to recite the pH of the electrolyte solution of the anode compartment and the concentrated chlorate produced has been specified to be from about 650 to about 1200 g/l. Support for these amendments can be found in claim 4 and in the specification at page 4, lines 15-16. No new matter has been added.

Claim 26 has been amended to be consistent with the amendment to claim 1. Again, no new matter has been added.

**II. The Invention:**

The presently claimed invention is directed to a process for producing alkali metal chlorate in an electrolytic cell that is divided by a cation selective separator into an anode compartment in which an anode is arranged and a cathode compartment in which a gas diffusion electrode is arranged. The process comprises introducing an electrolyte solution containing alkali metal chloride into the anode compartment and an oxygen-containing gas into the cathode compartment.

The present invention provides a process for producing alkali metal chlorate which avoids the problems of using alkali metal chromates associated with previously known processes that employ gas diffusion electrodes and avoids the costs and handling problems associated with using considerable amounts of hydrochloric acid and alkali metal hydroxide that are employed in other known processes, while at the same time provides an energy-efficient electrolytic process for the production of alkali metal chlorate and makes a large portion of externally added pH-adjusting chemicals superfluous.

### III. Rejections:

Claims 1-6, 9-11, 23, 24 and 26 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Millet (US 5,104,499), in view of Oda et al. (US 4,299,682). The Applicants respectfully traverse.

Millet discloses a one-stage electrolysis process for production of alkali metal chlorate (or perchlorate) in the absence of hexavalent chromium values without being coupled to another production. The cathode compartment of the cell contains an aqueous solution of hydroxide in which hydrogen is produced during the production (col.2, l.28-38).

Millet refers to a conventional process of producing chlorate or perchlorate **in a single stage** without a requirement of using a **special** electrode as indicated in the below list of major objects of Millet (col.2, l.22-27, 37-38):

- a) Improved process without presence of deleterious hexavalent chromium values
- b) No requirement for a special electrode
- c) No necessity of separating chloride prior to the desired chlorate
- d) No coupling of production of chlorate with any other production

In example 1 of Millet, agitation in the catholyte (providing for uniformity) is obtained by release of hydrogen at the cathode surface (col.4, l.45-47).

Applicants respectfully submit that they are unaware of any disclosure, teaching or suggestion by Millet that electrolyte is transferred to a chlorate reactor from the anolyte, as presently claimed. Rather, col.2, l.43-45, 58-60 teaches that "... chlorate produced may be directly separated or directly isolated from the electrolyzed aqueous anolyte by crystallization", i.e. without residing in a chlorate reactor for further reaction of the electrolyzed solution to produce a concentrated alkali metal chlorate electrolyte. Furthermore, col.2, l.61-63 sets out amounts of chlorate obtained which may range from 400 to 600 g/l in the anolyte which is subsequently separated or isolated (i.e. lower than the concentrated chlorate concentration as presently claimed).

The Office Action contends (at page 3) that “the claims do not further limit the structure of the reactor and the reactor (crystallizer) of Millet was capable of produced a concentrated alkali metal chlorate electrolyte by evaporation of water from the electrolyte. Thus, the disclosure of Millet is deemed to meet the transferring step as claimed.” Applicants respectfully disagree and submit that the Office Action is improperly and unreasonably ignoring elements of the claim language, construing the claim against the plain meaning as would be understood by one of ordinary skill in the art and contrary to the specification of the instant application.

In that regard, the claim recites a step of “transferring the electrolysed solution from the anode compartment to a chlorate reactor to react the electrolysed solution further to produce a concentrated alkali metal chlorate electrolyte” (emphasis added). The claim language clearly indicates that the solution is reacted (in a reactor) to produce more chlorate and a more concentrated chlorate solution and not just subjected to a concentration step (e.g., in a crystallizer) where other components are removed to produce a more concentrated solution of the chlorate originally present. It is submitted that this understanding of the claim language would be appreciated by one of ordinary skill in the art. Further, the specification specifically distinguishes a chlorate reactor from a crystallizer (see page 4, lines 2-8).

Further, as previously stated, the Office Action acknowledges Millet is silent on

- a) gas diffusion cathode in cathode compartment
- b) step of feeding oxygen-containing gas into the cathode compartment

The Office Action further acknowledges that “Of importance is that the reaction at the cathode of Millet produces hydrogen gas and hydroxide ions from the water”.

Applicants respectfully submit that the above would dissuade a person of ordinary skill in the art from:

- a) replacing the conventional **hydrogen-evolving** electrode for a gas diffusion electrode (no **special** electrode is needed as stated in Millet **and agitation** and

- uniformity is provided for by the hydrogen-evolving electrode in Millet); and
- b) making further modifications to the cell structure and provisions for introduction of oxygen-containing gas.

It is respectfully submitted that this teaching of the importance of producing hydrogen is not compatible with the position of the Office Action that it would be possible to replace the **hydrogen-gas evolving** conventional cathode with an **oxygen-reducing** gas diffusion cathode.

Oda teaches a gas diffusion electrode which imparts low over voltage, excellent reproducibility, excellent durability, and non-deteriorated catalytic activity (col.1, l.59-62).

With respect to the conclusion drawn in the Office Action, i.e. that it would be obvious to replace the hydrogen-evolving electrode of Millet with the gas diffusion electrode of Oda, it is respectfully submitted that Millet is not seeking to replace the electrode because Millet teaches that it is desirable that there is no requirement for a special electrode (see Millet at col.2, l.22-27). Furthermore, necessary agitation and uniformity are provided by the release of hydrogen at the cathode of Millet. It is submitted that it is not reasonable to conclude that the hydrogen-evolving electrode could readily be replaced. The suggestion by the Office Action (at page 14) that other means to provide agitation (instead of the release of hydrogen) could be provided is mere speculation and would require a more complicated and expensive system, e.g., additional mechanical equipment that is costly to run and/or different chemicals and associated equipment, as well as a source of oxygen that would require additional equipment, all at significant cost and contrary to the teaching of Millet.

The Office Action further contends that the "cathode reaction provided by the process cell of Oda et al is **similar** to the cathode reaction provided by the process of Millet." Applicants respectfully disagree. Although NaOH is formed in both reactions, the cathodic reactions are different as shown by the following:

$\text{H}_2\text{O} + 0.5 \text{O}_2 + 2\text{e}^- \rightarrow 2\text{OH}$  (Oda) including **reduction** of oxygen introduced in the cathode compartment at the gas diffusion electrode (col.2, l.32), i.e. another raw material present in the cathode reaction.

$2\text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{OH} + \text{H}_2$  this is the conventional hydrogen gas evolving reaction (Millet) without presence of introduced oxygen.

Furthermore, Oda is silent on production of chlorate and does not address any of the objects to be achieved in Millet, as discussed above.

Based on the above, it is respectfully submitted that there would thus be no reason for a person of ordinary skill in the art to combine Millet with Oda to arrive at the presently claimed invention.

Therefore, it is respectfully requested that the rejections of claims 1-6, 9-11, 23, 24 and 26 over Millet, in view of Oda et al, be withdrawn.

Claims 1, 3-6, 9-11 and 24-26 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Millet, in view of Shimamune et al (US 6,117,286). The Applicants respectfully traverse.

Shimamune et al teach an electrolytic cell employing a gas diffusion electrode which enables smooth gas feeding and energy savings for producing sodium hydroxide or hydrogen peroxide by electrolysis. Applicants respectfully submit, however, that they are unaware of any disclosure by Shimamune et al regarding the production of chlorate, in particular concentrated chlorate electrolyte in quantities as presently claimed.

Furthermore, there is no indication the pH of the anolyte electrolyte should be within the pH claimed which favors dissolution of chlorine (p.5, l.1-2) whereby electrolyzed solution containing chlorine and hypochlorous acid can be transferred to the chlorate reactor.

Finally, for the same reasons discussed above with respect to Millet and the fact that Shimamune et al teach, in line with Oda et al, applications for gas diffusion

electrodes other than chlorate production, replacement of hydrogen-evolving cathode would imply modifications of design and process conditions contrary to the teachings of Millet (e.g., agitation would no longer be provided by hydrogen evolved).

Therefore, it is respectfully requested that the rejections of claims 1, 3-6, 9-11 and 24-26 over Millet, in view of Shimamune et al, be withdrawn.

Claims 1-5, 7, 9-11 and 23 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Cook, Jr. (US Pat. No. 3,897,320), in view of Oda et al.. The Applicants respectfully traverse.

Cook is directed to the production of chlorate from alkali metal chloride solution in a two compartment cell equipped with an effective cation-active permselective membrane divider with the production of some chlorate in the anolyte and subsequent electrolysis of the anolyte in a chlorate cell (col.1, l.5-13).

Cook states that "an advantage of this invention is that alkali metal chlorate produced by transmission of hydroxide through the membrane into the anolyte is recovered and the anolyte is subsequently utilized as a feed to a chlorate cell (col.1, l.19-23). It is further set out that "because the cation-active permselective membrane 23 allows some hydroxyl ions to migrate through it from the catholyte to the anolyte these can react to produce chlorate in the anolyte" (col.2, l.10-12). Cook further teaches that the cation-active permselective membrane should permit from 5 to 50 percent of the caustic produced in the catholyte compartment to migrate to the anolyte compartment (col.7. l.10-13).

Claim 1 of the present invention differs from Cook in at least one aspect, as acknowledged by the Office Action, by defining the use of a gas diffusion electrode and introduction of oxygen-containing gas in the cathode compartment of the electrolytic cell.

Claim 1 is further distinguished from Cook by defining that the electrolyzed solution from the anode compartment is transferred to a chlorate reactor to further produce a concentrated chlorate electrolyte within the claimed range.

In contrast hereto, it is respectfully submitted that Cook teaches transferring the electrolyzed solution to a conventional **non-divided chlorate cell** electrolyzer rather than to a reactor. In such an undivided cell, further chlorate is formed in a **common** non-divided compartment.

The Office Action contends that the overall reaction provided by the process cell of Oda is identical to the process of Cook. Applicants respectfully disagree. As discussed above with regard to Millet, the reaction are different and the substitution of the Oda cell into Cook would require additional costly equipment, chemical and process changes, contrary to the teachings of Cook.

Thus, it is respectfully submitted that it would not be obvious to arrive at the present invention by replacing the existing hydrogen-evolving cathode of Cook with a gas diffusion electrode of Oda since Oda is silent on chlorate production and there is no reason based on Cook for a skilled person to modify or replace the cathode. Further, the process of Cook is so distinguished from the present invention that a person of ordinary skill would not replace the open non-divided chlorate cell with a chlorate reactor to which anolyte of the present process is transferred as claimed.

Regarding the remark on p.8, last 2 of the Office Action that "...Additionally, the membrane of Oda et al would have permitted a small amount of the hydroxide ions to cross, similarly to Cook, Jr.,...", as discussed in Applicants previous response:

*A cation selective separator allows transmission of cations such as sodium but restricts transmission of anions through the membrane (cf. spec., p.3, l.9-12). A cation selective separator is thus designed only to allow cation transmission.*

In view of the above, the possible transmission of some hydroxide ions of a conventional cation selective membrane would be negligible in view of the special permselective membrane of Cook. It is respectfully submitted that the contribution of such an amount of transmitted hydroxide ions could only possibly result in insignificant amounts of chlorate and would not be recognized by one of ordinary skill in the art without hindsight of the present application.

Therefore, it is respectfully requested that the rejections of claims 1-5, 7, 9-11 and 23 under 35 U.S.C. § 103(a), as being obvious over Cook, in view of Oda et al, be withdrawn.

Claims 1-6, 8, 10-12, 23 and 26 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Wanngård (US 5,419,818), with evidence from Cook, and in view of Oda et al. The Applicants respectfully traverse.

Wanngård relates to an integrated process involving a **conventional** hydrogen-evolving cathode. Wanngård regards the problem of reducing chemicals added in the conventional processes for acidification and alkalization (col.2, l.50-52). The electrolysis in the cell equipped with a separator yields an anolyte and a catholyte having lower and higher pH respectively than the chlorate electrolyte supplied to the separator-equipped cell (col.2, l.67-col.3, l.2). As correctly acknowledged by the Office Action (p.11, l.3), **no chlorate** is produced in the divided cell.

Consequently, it is respectfully submitted that a skilled person would have no reason to modify the teaching of Wanngård in such a way that the process of instant claims 1 and 26 is arrived at since Wanngård is not aiming at providing:

- a) a divided chlorate-producing cell, and particularly not
- b) a divided chlorate cell equipped with a gas diffusion electrode.

On the contrary, since several parameters differ between divided and undivided chlorate cells including e.g. mixing conditions of electrolyte, control of pH, need of supplying acid/hydroxide, it is submitted that one of ordinary skill in the art would not



look to technology describing divided chlorate cells, particularly not in Oda and Cook since:


- a) Oda and Cook are silent on integrated production of acid and alkali metal hydroxide;
- b) Cook uses a permselective membrane and the anolyte is transferred to a further **non-divided** electrolyzing cell rather than to a chlorate reactor for production of concentrated chlorate as presently claimed;
- c) Cook is silent on the use of gas diffusion cathodes arranged in divided cells; and
- d) There is no incentive in Wanngård to replace the conventional hydrogen-evolving cathode (as explained above).

Therefore, it is respectfully requested that the rejections of claims 1-12 and 23 under 35 U.S.C. § 103(a), as being obvious over Wanngard, as purportedly evidenced by Cook, in view of Oda et al., be withdrawn.

**Conclusion:**

In light of the foregoing, Applicants respectfully submit that the application as amended is now in proper form for allowance, which action is earnestly solicited. If the Examiner has any questions relating to this Amendment or to this application in general, it is respectfully requested that the Examiner contact Applicants' undersigned attorney at the telephone number provided below.

Respectfully submitted,

  
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